RECORD OF CHANGES

CHANGE NO.	DATE OF CHANGE	TITLE OF BRIEF DESCRIPTION	ENTERED BY
1	15 Jul 96	Permanent Change One	
Errata for Change 1	3 Feb 97	Replacement Pages for Permanent Change 1	
Diving Advisory 97-02 IC 1	3 Feb 97	BUMED Action Codes and telephone numbers and subspecialty codes for undersea medical officers	
Diving Advisory 97-06 IC 2	17 Mar 97	General guidance to assist activities in minimizing their risk and raising the awareness of divers to the inherent risks associated with the use of electricity underwater.	
Diving Advisory 98-03 IC 3	23 Jan 98	Clarifies diver air sampling program procedures and periodicity changes.	

4-5.7.1 Underwater Electrical Safety

1. Although equipped with test buttons, electrical ground fault interrupters (GFI) often do not provide any indication when the unit has experienced an internal component failure in the fault circuitry. Therefore, GFI component failure during operation (subsequent to testing the unit) may go unnoticed. Although this failure alone will not put the diver at risk, the GFI will not protect the diver if he is placed in contact with a sufficiently high fault current. The following is some general information concerning GFIs:

a) GFIs are required when line voltage is above 7.5 VAC or 30 VDC.

b) GFIs must be capable of tripping within 20 milliseconds (ms) after detecting a maximum leakage current of 30 milliamps (ma).

IC 2

c) GFIs require an established reference ground in order to function properly. Cascading GFIs could result in loss of reference ground, therefore, GFIs or equipment containing built-in GFIs should not be plugged into an existing GFI circuit.

2. In general, three independent actions must occur simultaneously to electrically shock a diver:

a) The GFI must fail.

b) The electrical equipment which the diver is operating must experience a ground fault.

c) The diver must place himself in the path between the fault and earth ground.

3. The only effective means of reducing electrical shock hazards are to ensure:

a) Electrical equipment is properly maintained.

b) All electrical devices and umbilicals are inspected carefully before all operations.

c) Electrical umbilicals are adequately protected to reduce the risk of being abraded or cut when pulled over rough or sharp objects.

d) Personnel are offered additional protection through the use of rubber suits (wet, dry, or hot water) and rubber gloves.

IC 2

e) GFI circuits are tested at regular intervals throughout the operation using built-in test circuits.

4. Divers operating with remotely operated vehicles (ROVs) should take similar precautions to ensure the ROV electrical system offers the required protection. Many new ROVs use extremely high voltages which make these protective actions even more critical to diver safety.

$$\frac{2000 - 250}{14.7} \times (.420 \times 2) = V_a = 100\ scf$$

The duration of the air supply is found using equation 3:

$$Duration = \frac{100\ scf}{3.75\ scfm} = 26.66\ minutes$$

In this example, the total time for the dive, from initial descent to surfacing at the end, is limited to 26 minutes.

5-3.2 Standards for Compressed Air. Compressed air must contain adequate oxygen and be free of excessive contamination from carbon monoxide, carbon dioxide, gaseous hydrocarbons, particulates (dirt and dust), oil mist, and other impurities. Contaminated breathing air can cause illness, unconsciousness, or death. Air used in SCUBA operations must meet the standards of purity established by the Commander, Bureau of Medicine regardless of the source of the air or the method used for charging the cylinders. These standards are:

- Oxygen concentration - 20-22% by volume
- Carbon dioxide - 1,000 ppm maximum
- Carbon monoxide - 20 ppm maximum
- Total hydrocarbons other than methane - 25 ppm maximum
- Particulates and oil mist - 5mg/m^3 maximum
- Odor and taste - not objectionable

These standards are applied to nonsaturation air dives and are measured at standard temperature and pressure. During normal gas analysis, hydrocarbons are first converted to methane and analyzed. The actual methane value is then subtracted from this result to give the value for unknown hydrocarbons. Unknown hydrocarbons should not exceed 25 ppm.

The Naval Sea Systems Command requires that an air sample be obtained semiannually from each air supply source in operable condition (Appendix I). To ensure the safety of Navy divers, NAVSEASYSCOM has established a unified program for sampling divers' breathing air. The Coastal Systems Station in Panama City, Florida has been designated as the central authority to schedule the sampling of the divers' air sources in use, and to ensure that the air samples are analyzed by a qualified laboratory. Air sampling services may be acquired via Coastal Systems Station administered air sampling program, or local military (shipyards, ship repair facilities, etc.) or local commercial gas analysis facilities. Obtaining air sampling services from outside the CSS coordinated program does not relieve the command of the responsibility to meet the purity standards of Appendix L. It follows that great care must be exercised in selecting an air sampling facility outside the CSS coordinated program.

IC 3

5-3.3 Other Sources for Air. Compressed air meeting the established standards can usually be obtained from Navy sources. In the absence of appropriate Navy sources, air may be procured from commercial sources. Usually, any civilian agency or firm which handles compressed oxygen can provide pure compressed air. Air procured from commercial sources must meet the requirements of Grade A or C air as specified by FED SPEC BB-A-1034A and the diving air purity standards.

Air procured from any source must be contained in cylinders which meet required legal standards for high-pressure compressed air. Cylinders must bear a serial number, a DOT inspection stamp, a pressure rating, and the date of the last hydrostatic test.

5-3.4 Methods For Charging SCUBA Cylinders.

NOTE

Paragraph 5-3.5 addresses safety precautions for charging and handling cylinders.

SCUBA cylinders shall be charged only with air that meets diving air purity standards. A diving unit can charge its own cylinders by one of two

- **Diving ladder -** Used for entering the water from a vessel.

- **Cast iron weights -** Provided in two sizes: 50- and 100-pound clumps. Both sizes are used as descent line weights.

- **Canvas toolbag -** Used for carrying tools.

- **Stopwatches** - Used for timing the total dive time, decompression stop time, travel time, etc.

6-7 SURFACE AIR SUPPLY SYSTEMS

The diver's air supply may originate from an air compressor, a bank of high-pressure air, or a combination of both.

6-7.1 Requirements for Air Supply.

Regardless of the source, the air must meet certain established standards of purity (Appendix L), must be supplied in an adequate volume for breathing, and must have a rate of flow which will properly ventilate the helmet or mask. The air must also be provided at sufficient pressure to overcome the bottom water pressure and the pressure losses due to flow through the diving hose, fittings, and valves. The air supply requirements depend upon specific factors of each dive such as depth, duration, level of work, number of divers being supported, and type of diving system being used.

6-7.1.1 Air Purity Standards. If taken directly from the atmosphere and pumped to the diver, air may not meet established purity standards. It may be contaminated by engine exhaust or chemical smog. Initially pure air may become contaminated while passing through a faulty air compressor system. For this reason, all divers' air must be periodically sampled and analyzed to ensure the air meets purity standards (Appendix L). The quality of the air of any supply system must conform to the following limits:

- Oxygen concentration=20-22% by volume

- Carbon dioxide=1,000 ppm maximum

- Carbon monoxide=20 ppm maximum

- Total hydrocarbons other than methane* =25 ppm maximum

  * During normal gas analysis, hydrocarbons are first converted to methane and analyzed. The actual methane value is then subtracted from this result to give the value for the unknown hydrocarbons. Unknown hydrocarbons should not exceed 25 ppm.

- Particulates and oil mist=5mg/m^3 maximum

- Odor or taste=Not objectionable

To meet these standards, specially designed water-lubricated compressors must be used, or the air supplied by a standard compressor must be passed through a highly efficient filtration system. The compressed air found in a shipboard service system usually contains excessive amounts of oil and is not suitable for diving unless filtered. Air taken from any machinery space, or downwind from the exhaust of an engine or boiler, must be considered to be contaminated. For this reason, care must be exercised in the placement and operation of diving air compressors to avoid such conditions. Intake piping or ducting must be provided to bring uncontaminated air to the compressor-. The outboard end of this piping must be positioned to eliminate sources of contamination. To ensure that the source of diver's breathing air, whether a compressor or HP bank, satisfactorily meets the standards established above, it must be checked semiannually (as described in Appendix I) in accordance with the PMS.

IC 3

U.S.Navy recompression treatment procedures has shown they are effective in relieving symptoms over 90% of the time when used as published. Deviation from these protocols should be made only in exceptional circumstances.

In addition to individuals suffering from diving disorders, U.S. Navy recompression chambers are also permitted to treat individuals suffering from cyanide poisoning, carbon monoxide poisoning, gas gangrene, smoke inhalation, or arterial gas embolism arising from surgery, diagnostic procedures, or thoracic trauma. If the chamber is to be used for treatment of nondiving related medical conditions other than those listed above, authorization from MED-21, (202) 762-3444 or 762-3449, DSN 762-3444 or 762-3449, must be obtained before treatment begins (BUMEDINST 6320.28B). IC 1

Recompression treatment is designed to accomplish three primary objectives: (1) to compress gas bubbles to a small volume, thus relieving local pressure and restarting blood flow, (2) to allow sufficient time for bubble resorption, and (3) to increase blood oxygen content and thereby oxygen delivery to injured tissues.

Table 8-1 gives the basic rules that must be followed for all recompression treatments. A list of standard treatment tables is given in Table 8-2.

Certain facets of recompression treatment have been mentioned previously, but they are so important that they cannot be stressed too strongly.

1) Treat promptly and adequately. Adopt the degree of urgency warranted by the patient's condition as outlined in Paragraph 8-11.

2) The effectiveness of treatment decreases as the length of time between the onset of symptoms and the treatment increases.

3) Do not ignore seemingly minor symptoms. They can quickly become major symptoms.

4) Follow the selected treatment table unless changes are recommended by a Diving Medical Officer.

5) If multiple symptoms occur, treat for the most serious condition. In order of increasing severity, they are: Type I DCS, Type II DCS and AGE.

Recompression in a facility equipped for oxygen breathing is preferred. However, the procedures covered here also address situations where either no chamber is available or where only air is available at the recompression facility. Inwater or air recompression treatments are used only when the delay in transporting the patient to a recompression facility having oxygen would cause greater harm.

8-12 PRESCRIBING AND MODIFYING TREATMENTS

When treatments of diving accidents are assisted by personnel other than credentialed Diving Medical Officers (DMOs) that are privileged by the treatment facility Commanding Officer, they must be in compliance with this manual.

Not all Medical Officers are DMOs. The DMO must have graduated from the Diving Medical Officer course taught at the Naval Diving and Salvage Training Center (NDSTC). DMOs will have subspecialty codes of 16U0 or 16U1 (Undersea Medical Officer). Saturation Diving Medical Officers have an Additional Qualification Designator (AQD) of 6UD and Submarine Medical Officers an AQD of 6UM. Medical Officers who only complete the short diving medicine course at NDSTC do not receive DMO subspecialty codes but are considered to have the same privileges as DMOs when treating diving acci- IC 1

APPENDIX I

DIVER'S AIR SAMPLING

I-1 INTRODUCTION

Diver's breathing air must be free of carbon monoxide (CO), carbon dioxide (CO_2), oil vapor, and other impurities (see Appendix L). Many gaseous and particulate contaminants adversely affect the human body when the partial pressure of the gases is increased. To monitor diver breathing air purity, the Naval Sea Systems Command (NAVSEASYSCOM) has established an air sampling program which is described in NAVSEA Note 9597, Diver's Breathing Air Sampling Program for Compressed Air Sources, 27 May 1977. The NAVSEASYSCOM air sampling program is administered by the Coastal Systems Station, Panama City Beach, FL 32407-5001 (COASTSYSTA).

I-2 DEFINITIONS

- **Contractor** - Qualified analytical laboratory that supplies the sampling equipment and analytical services.
- **Managing Activity** - Naval activity administering the program (COAST-SYSTA).
- **Sponsor** - Naval Sea Systems Command.
- **User** - Activity, group, ship, command, etc., with a diving capability.
- **Sampling Fit** - Kit of sampling equipment tailored to the user's needs, packaged and sent to the user by the contractor.
- **Sample Set** - Complete set of specimens (samples) obtained from an air supply source. The set consists of the following:
  - (1) Particulate sample (filter pad).
  - (2) Diving air sample.

I-3 SAMPLING PROCEDURES

I-3.1 Administration.

- **Sampling Period** - Each diver breathing air source in service must be checked for purity semiannually in accordance with PMS. IC 3
- **Action Upon Detection of Substandard Samples** - The user will be contacted by phone and message as quickly as possible by COASTSYSTA if the sample fails to meet established purity standards. The user will discontinue use of the air source until cause of contamination is corrected. The laboratory will aid in determining the cause of the bad sample and advise if resampling is necessary.
- **Sampling Schedule** - COASTSYSTA will coordinate scheduling for commands requesting divers air samples, but diving commands may elect to use other military as well as commercial analysis facilities. The user shall notify the COASTSYSTA representative via telefax or message approximately four to six weeks prior to sample expiration date. The user must provide the sample expiration date, the number and type of samples required, a complete mailing address, user point of contact and correct phone number. Only when the information requested above is provided will an air sample kit be shipped. Commands requesting air samples should schedule **all** compressors and associated samples to be taken at the same time. Each IC 3